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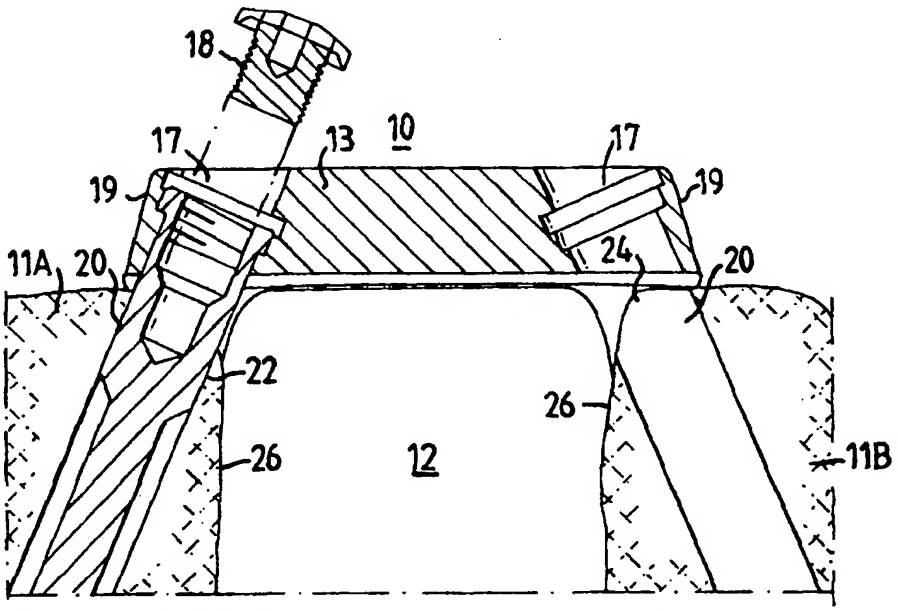
(54) Title: A VERTEBRAL FIXATING DEVICE

(57) Abstract

A vertebral fixating device which is intended to be fitted on the ventral side of the spine to fixate adjacent vertebrae (11A, 11B). The device includes a generally rectangular plate (13) whose length slightly exceeds the distance between the adjacent vertebrae (11A, 11B), elongated fastening devices (22) for fastening the plate (13) to the vertebrae (11A, 11B), through-penetrating holes (17) which are angled cranially on the cranial side of the plate (13) in the dorsal direction, and which are angled caudally on the caudal side (16B) of the plate (13) in the dorsal direction. The holes are intended to receive fastening devices (22), and the fixating device includes securing devices (18) for locking the fastening devices (22) to the plate (13), and at least one pair of pins provided respectively on the cranial and caudal sides of the plate (13) for holding the plate (13) in position when anchoring the plate with the aid of the fastening devices (22).



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A vertebral fixating device

The present invention relates to plate-like devices for fixating vertebrae in relation to one another, and more specifically to devices that are intended to be fitted to the ventral side of the spine with the intention of fixating at least two mutually adjacent vertebrae in relation to one another, for instance in conjunction with removing intervertebral discs, said devices including generally rectangular plates having generally rounded corners, and elongated fasteners, such as screws, for fastening the plates to the adjacent vertebrae, fastener-receiving penetrating holes provided at at least the corners of the plate, fastener securing or locking devices for fixing the fasteners in plate-attached positions, and at least one pair of pins arranged on the dorsal side of the plates and at their cranial and caudal sides respectively, for holding the plates in position as they are fastened by said fasteners.

US-A-3,741,205 describes a bone fixation plate which includes at least one removably attached fixation device at each end. The fixation devices protrude from one and the same side of the plate and it is said that these devices may be angled convergently or divergently in relation to one another. The fixation devices are angled with the intention of preventing the plate loosening from the bone or bones.

DE-A1-4,038,082 describes a vertebrae fixating or connecting device, which includes a plate comprising two vertebrae connecting sections and an intermediate, possibly narrower connecting section. The vertebrae connecting sections are provided with penetrating, screw-threaded holes and also with screws which correspond to said screw-threaded holes and which are intended to affix the plate to the vertebrae.

EP-A1-0,506,420 and EP-A1-0,507,162 describe bone fixating devices which, as is evident from the descriptive parts of these publications, are contemplated for lateral positioning. Briefly, the problem which the inventors intended to solve resides in the difficulties encountered in providing a vertebrae fixating plate

which will afford a high degree of flexibility with regard to positioning of bone screws for instance, when fitting the plate onto vertebrae.

The device disclosed in EP-A1-0,506,420 includes a plate which is provided with an elongated recess for accommodating fastening screws. The plate is fixed to the vertebrae, for instance, by means of such screws and generally stirrup-shaped plates. The stirrup-shaped plates are rectangular and are provided centrally with holes for receiving the screws. The underside of the stirrup-shaped plates is provided on the short sides thereof with particularly formed projections which fit into sawtooth-like notches on the long sides of the plate, thereby enabling the plates to be affixed laterally at several positions along the plate; both the stirrup-shaped plates and the fixation plate can then be screwed firmly to the vertebrae. The screw holes provided in the stirrup-shaped plates may be angled.

The screw holes in the stirrup-shaped plates are countersunk to accommodate the heads of the screws. These screw holes are countersunk so as to obtain more uniform pressure distribution and to improve other, purely mechanical properties.

The device disclosed in EP-A1-0,507,162 resembles in many aspects the device disclosed in EP-A1-0,506,420, but with the difference, among other things, that the sawtooth-like grooves or notches are provided on the upper side of the plate; the function, however, is essentially the same.

The bone screw securing devices used in known techniques are generally comprised solely of simple screw joints, such as nuts, for instance. One exception is found in a device disclosed in CH-A5-648,197, which includes a bone screw whose head has the form of a laterally deformable collar which includes an inner conical surface. In use, a separate adjusting screw having a conical surface corresponding to the bone screw is screwed coaxially into the head of the bone screw, therewith deforming said collar outwardly against the wall of the screw hole. This results in elevated friction between the screw head and the hole

wall, which counteracts any tendency of the screw joint to loosen.

EP-179,695, EP-425,783, US-A-4,743,256, US-A-4,836,196, US-A-4,892,545, US-A-5,092,893, US-A-4,636,217 and DE-3,729,600 describe devices whose relevance to the present invention is of a more peripheral nature, and consequently these publications will not be described in detail here.

When implanting devices of the aforesaid kind, it is necessary to remove primarily periosteum from that surface of the bone which is intended to form an abutment surface, in order to provide an acceptable plate abutment surface. For medical reasons, among other things, it is desirable to make the surgical area, and therewith the abutment surface, as small as possible, so as to minimize the negative effect of the surgical operation on the periosteum. One problem in this respect is that of providing a reduced abutment surface without reducing the mechanical strength and durability of the fixation at the same time.

Another problem resides in improving the security of fixation of the plate to the vertebrae without, at the same time, increasing the risk of greater loads on the vertebrae when wishing to remove the plate, for some reason or another.

Another, general problem with vertebral fixating plates, particularly those plates that are placed on the ventral side of the spine, resides in the risk of damaging surrounding organs, for instance aorta, as a result of the shearing and wearing effect of the implant.

The object of the present invention is to provide a vertebral fixating device which will greatly reduce or fully eliminate the aforesaid problems.

This object is achieved with a device of the kind mentioned in the introduction which is characterized in that

a) the length of the plate slightly exceeds the distance between the adjacent vertebrae, by distance being meant in this case the shortest path between the vertebrae;

b) the penetrating holes located on the cranial side of the plate in a dorsal direction are angled cranially while the penetrating holes located at the caudal side of the plate in a dorsal direction are angled caudally; and

c) the fastening-device securing devices include movable parts which lock firmly into recesses in the inner surfaces of the penetrating holes and/or in the fastening devices.

The cranial and caudal angling of the penetrating holes in relation to a dorsally extending normal to the plate may be 10°-30°, for instance.

Because the length of the plate may only slightly exceed the distance between the vertebrae, there is obtained a considerable reduction in the abutment surface in relation to known techniques, which surprisingly enough have not afforded any solution to the problem concerning the size of this surface area, despite the fact that the average person skilled in this art must have been aware of the problem; the desire to heal with the smallest possible means and the smallest possible surgical operation is, after all, an obvious and paramount aim of such a person.

As will be understood, the abutment surface can be further reduced by defining said surface with the aid of a few projections which extend out from the dorsal side of the plate in the vicinity of the caudal and cranial side respectively. These projections may, for instance, have the form of ring-shaped members which surround the screw hole outlets, or may simply be comprised of the aforesaid pins.

As will be understood, in order to fasten the plate to the vertebrae, it is necessary for the screw holes to be placed as close as possible to the caudal and cranial side of the plate respectively. The prior techniques do not strive to place the

screw holes in such positions, since it would scarcely lead to any positive effect, either when taken alone or in combination with known techniques. However, in order to obtain good anchorage of the fastening devices in the vertebrae when the length of the plate only slightly exceeds the distance between the vertebrae, it is necessary to angle the holes on the caudal side in the caudal direction, and to angle the holes on the cranial side in the cranial direction. The cranially placed and caudally placed fastening devices may be parallel with one another, or alternatively may converge or diverge in relation to one another. In order to avoid the risk of damaging the medulla spinalis (the spinal cord), the fastening devices will preferably diverge at an angle, for instance, of 10°-30° in relation to a dorsally extending normal to the plate.

The known technique does in fact not lack recommendations of angling screw holes at different angles; this angling, however, is generally of a converging kind for mechanical strength reasons, as will be apparent to the person skilled in this art. Although US-A-3,741,205 mentions the possible divergent angling of the fastening devices, this disclosure is not supported by any described embodiment or figure; on the contrary, in one embodiment, these fastening devices extend from corner-located holes along the normal to the spherical surface which passes through the corner holes, and are thus convergent in relation to one another. The fastening devices illustrated in Figures 2-4 all have convergent directions. Surprisingly, only convergent angling is mentioned in the Claims. The publication makes no disclosure of any caudal and/or cranial orientation. It is evident from the text of DE-A1-4,038,082 and from Figures 1B and 1D that the screw holes converge in the dorsal direction. There is no mention of caudal and/or cranial orientation of the screw holes.

EP-A1-0,506,420 describes only one embodiment in which all fastening screws are angled cranially.

EP-A1-0,507,162 discloses only that the bone screws can be angled in relation to the length and transverse directions of

the plate; when no disclosure is made as to how the bone screws are intended to be angled, the person skilled in this art would consider it obvious that the screws shall be given a mutually converging orientation.

Because the present invention thus deviates from the path pointed to by the known techniques, i.e. by angling the fastening devices cranially/caudally in accordance with the aforegoing instead of conventionally angling the fastening devices in a convergent orientation, there is created in combination with the plate whose length only slightly exceeds the distance between the adjacent vertebrae conditions for achieving stable fixation of the vertebrae with the minimum effect on the vertebrae surfaces.

Even though in principle these two features in combination with one another, and possibly also with a conventional fastener locking or securing device, would be sufficient to achieve fixation, it is suitable in practice when wishing to enable the patient to move in a manner which would affect the vertebrae in some way, at least after some time has lapsed since the operation was completed, it is generally necessary to secure the positions of the fastening devices with the aid of particularly reliable securing or locking devices, so as to eliminate the risk of the fastening devices loosening as a result of patient movement.

Accordingly, the present invention includes securing devices which have movable parts which may be arranged on the fastening devices, the inner surfaces of the holes, separate parts or a combination of these possibilities, said parts being intended to be locked firmly in recesses provided on the fastening devices, the inner surfaces of the holes, separate parts, or a combination of these possibilities, when fastening the fixation device to the vertebrae with the aid of the fastening devices. To some extent, this locking feature resembles the function of a conventional door bolt lock. When locking or securing the fastening devices, the movable part is moved along one path and then over the edge of a recess at the same time as it is influenced by a

force in the direction of the recess, so as to move said part from the edge of the recess to the bottom thereof, therewith preventing said part from moving mechanically at least rearwardly along said path.

Although fastening screw securing devices are known in the technical field to which this invention relates, these devices solely have the form of single screw-thread joints or the like, as before mentioned. As mentioned above, it would seem that the device described in CH-A5-648,197 is an exception in this respect, although a closer study shows that even in this case the securing effect is based on a screw joint and thus suffers the deficiencies associated with such joints, i.e. primarily the risk of unscrewing. Thus, the securing devices do not represent a mechanical obstacle to loosening of the fastening devices, in distinction to the present invention. Neither would the device taught by the Swiss patent specification appear to afford any particular advantage with regard to preventing loosening of the fastening devices, but is constructed rather to prevent the occurrence of narrow slot-like spaces between fastening devices and implant and/or between implant and bone, these spaces otherwise enabling the implant to move in small "micromovements" around the position essentially defined by the fastening devices. The solution provided by CH-A5-648,197 with regard to securing the fastening devices is actually comprised of providing the fastening devices with a recess or the like into which bone is intended to grow. Naturally, this provides an extremely secure joint, although with the great disadvantage that, in practice, it is almost impossible to remove the fastening devices and the implant should this be desirable for some reason or another.

The inventive device does not suffer this drawback; the fastening devices can be optionally designed to be able to grow firmly in the bone or not. The securing devices form obstacles of a generally mechanical nature against loosening of the fastening devices, while any tendency towards "micromovements" is prevented by the fastening devices and their particular mutual angling. Even should the securing devices be connected to the

fastening devices by means of screw-threaded joints and this screw-threaded joint should be unscrewed, or backed-off, the implant would still not begin to move immediately around those points defined by the fastening devices, as distinct from the device taught by CH-A5-648,197.

The length of the plate will preferably exceed the distance between the adjacent vertebrae by 1-10 mm, preferably 1-5 mm.

By "plate" is meant in the instant document a generally flat body which may possibly be provided with one or more recesses, holes or the like, which may optionally be penetrating. For instance, the plate may be provided along its lateral sides with holes by means of which the plate can be held with the aid of a suitable tool, for instance a gripping tool, when moving or fitting the plate.

The mechanical locking function of the securing device is preferably of a kind which can be termed a "snap-locking function", meaning that in the actual locking process the movable parts in principle pass sequentially through three stages as they approach their locking position: I) The movable parts are caused to move by some influencing force, wherewith said parts store potential energy; II) the stored potential energy reaches a maximum when the movable parts reach a given, possibly labile position; whereafter, III) the stored potential energy is converted to kinetic energy and the movable parts move abruptly until they reach a stable position. In order to remove the locked device, it is thus necessary to supply energy corresponding at least to said energy maximum.

According to one particularly preferred embodiment, the securing device is provided with a screw-thread and/or some form of protrusion and is, in general, designed to fit into a recess in a fastening device provided with a corresponding screw-thread and/or a recess corresponding to said protrusion and which is located at that end which lies nearest the ventral surface of the plate; the securing device is also provided at that end which lies nearest the ventral surface of the plate when the

securing device is in its locking position with movable parts in the form of at least one outwardly projecting member which protrudes from the side of the securing device. This member may define an acute angle, an obtuse angle or a right angle with the longitudinal axis of the securing device. The member may have a rotational-symmetrical form, wherein its symmetry axis is essentially coaxial in relation to the longitudinal axis of the securing device; this rotational-symmetrical form may be comprised of a circular disc or of a cup-like, dish-like or funnel-like member or some other similar member. The rotational-symmetrical form may be either complete or divided into sectors, segments or the like. The movable part or parts of this embodiment is/are preferably produced from an elastically deformable material. The penetrating holes are preferably so formed that no part of the fastening devices, the securing devices or any other part of the fixation device will protrude or lift above the ventral surface of the plate when the fixation device is used for its intended purpose. This minimizes the risk of damage to surrounding organs.

So that the invention will be more readily understood, the invention will now be described in more detail with reference to the accompanying drawings, in which

Figure 1 is a general view of one embodiment of the inventive fixation device when positioned to fixate two mutually adjacent vertebrae;

Figure 2 is a sectional view taken on the line II-II in Figure 1;

Figure 3 is a sectional view taken on the line III-III in Figure 1;

Figure 4 is a sectional view taken on the line IV-IV in Figure 1;

Figure 5 illustrates a fastening device, partly in section;

Figure 6A is an end view of a securing device;

Figure 6B is a sectioned view of the securing device shown in Figure 6A;

Figure 7 is a more detailed sectional view of one of the penetrating holes, and shows a fastening device and a securing device positioned for fixation;

Figure 8 illustrates a securing device according to another embodiment of the invention; and

Figure 9 illustrates another embodiment of the invention, in which the fixation device fixates three adjacent vertebrae.

Figure 1 illustrates a vertebrae fixating device 10 which is intended to fixate two adjacent vertebrae 11A, 11B on the ventral side of the spine in relation to one another. Located between the vertebrae 11A, 11B is a body 12, which may be an intervertebral disc or a prothesis for such a disc, or some other body of a synthetic of natural kind, possibly a part taken from the patient's own body that can replace an intervertebral disc. The illustrated fixation device 10 includes a generally rectangular plate 13 which extends in the direction of its longitudinal axis over the intermediate body 12 and lies partially against the edges 14 of the adjacent vertebrae 11A, 11B. The plate 13 is provided at its corners 15, in the vicinity of the respective cranial and caudal short sides 16A, 16B of the plate, with through-penetrating holes 17 through which fastening devices 22 (shown in Figure 2) are intended to fix the plate 13 to the vertebrae 11A, 11B. Also provided in the holes 17 are fastener-device securing devices 18 which are intended to secure the position of the fastening devices 22 and to prevent the strength of the joint between plate 13 and vertebrae 11A, 11B diminishing. As will be seen from Figure 1, the length of the plate 13 exceeds the distance between the vertebrae 11A, 11B by only a small part of the total length of the plate 13. For size and weight reasons, and also to reduce any negative effect on

peripheral organs, the plate 13 is provided with a bevelled or chamfered edge 19.

Figure 2 is a sectional view taken on the line II-II in Figure 1. For the sake of illustration, there is shown one of the caudally located holes 17 and a corresponding hole 20 in the vertebrae 11A, with a fastening device 22 fitted so as to fix the plate 13 to the vertebrae 11A, and a corresponding securing device 18 is shown in a position immediately prior to being inserted into or after being removed from the hole 17; the Figure also shows an empty second hole 17, with no fastening device or securing device fitted therein. As will be seen from Figure 2, the inlets 24 of the hole 20 are located in the proximity of or, alternately, completely or partially on the ends 26 of the adjacent vertebrae 11A, 11B. The illustrated angling of the holes 17, 20 is necessary in order to achieve requisite anchorage of the fastening devices 22 and therewith fixation of the device 10 to the vertebrae 11A, 11B with acceptable strength. This angling provides room to bevel the edge 19, which is an advantage as mentioned above.

It will be seen from Figure 3, which is a sectional view taken on the line III-III in Figure 1 (for reasons of illustration shown without fastening devices and securing devices), in combination with Figure 2, that the holes 17 in the plate 13 are angled caudally at a caudal vertebrae and cranially at a cranial vertebrae, and that all holes are angled laterally. That surface 30 of the plate 13 which lies proximal to the spine (the lower or dorsal surface) is further constructed to fit against at least that part of the spine on which the inventive device is intended to lie. As seen from the surface of the plate 13 which lies distal to the spine (the upper or ventral surface), the holes 17 are divided so as to include an inlet 33, thereafter an upper groove or recess 34 the diameter of which is greater than the diameter of the inlet 33 and which is delimited by a bottom surface 34A, a bottom groove or recess 36 which has generally the same diameter as the inlet 33 and which is downwardly (dorsally) delimited by a ring-shaped surface 36A, and finally an

outlet 38 which has a smaller diameter than the inlet 33 and which extends out from the bottom surface 30.

Figure 4 is a sectional view taken on the line IV-IV in Figure 1. As will be seen from Figure 4, the plate 13 is provided at its caudal and cranial ends with pins 31 whose main purpose is to hold the plate in position when, for instance, drilling holes 20 in the vertebrae 11A, 11B with a drill which passes through the holes 17 in the plate 13, and/or while securing the plate with fastening devices 22. In the case of the Figure 4 embodiment, the pins 31 are removable and are designed to be fastened in holes 35, with the aid of a screw joint, said holes optionally being through-penetrating. The removable pins 31 include an externally threaded part 37 corresponding to the threads in the hole 35, and a conical or pointed part 39 which, in use, is intended to grip or bite into the surface of the vertebrae edges 14 (Figure 1). Naturally, the pins may have any form suitable for the intended purpose and may also be formed integrally with the plate.

Figure 5 illustrates a fastening device 22, which in this case has the form of a screw. It will be understood that the fastening device may have the form of any device or combination of devices able to affix the inventive fixation device to a vertebrae 11A or 11B. The fastening device 22 has a generally smooth stem part 41 having a diameter which will enable the stem part to fit into the outlet part 38 of the hole 17 in the plate 13. The stem part is provided at the end thereof with a stop means 42 which is defined externally of the fastening device 22 by an end surface 43, a bevelled or chamfered edge surface 44, a cylindrical side surface 45 and a ring-shaped surface 46. The stop means 42 is configured to fit into the recess 36. When the fastening device 22 is used to fix the plate to a vertebrae, the ring-shaped surface 46 will thus lie against the ring-shaped surface 36A. The fastening device is also provided with a cylindrical, screw-threaded recess 47 which extends coaxially with the longitudinal axis of the fastening device 22, inwardly from the end surface 43, this recess being intended for attachment of the securing device 18. Provided on that end of the recess 47

which is opposite the end surface 43 is a further recess 48, which may have an hexagonal cross-section and into which the fastening device 22 can be screwed, for instance with the aid of an hexagonal wrench.

The securing device 18 is illustrated in more detail in Figure 6A, which is an end view of said device, and in Figure 6B, which is a sectioned end view of said device. The illustrated securing device 18 includes a cylindrical part 50 which is configured to fit into the recess 47 in the fastening device 22 and is provided with a thread corresponding to the thread of the recess 47. The securing device 18 also includes movable parts 52 which are intended to lock the screw 22 firmly when the securing device is used. A recess 58 is provided at the same end of the securing device 18 as the movable parts 42. The recess 58 extends coaxially with the longitudinal axis of the device 18 and has a cross-section which enables the device 18 to be fitted into the recess 47, for instance an hexagonal cross-section which enables the device 18 to be screwed in with the aid of an hexagonal wrench.

In the illustrated embodiment, the movable parts are comprised of four essentially identical parts which, when considered along the longitudinal axis of the securing device 18, have the form of sectors of a circle with a diameter which is slightly greater than the diameter of the inlet 33 of the hole 17, and are produced from an elastically deformable material. The movable parts 52 also define angles with the inlet 33 of the hole 17, and are made of an elastically deformable material. The movable parts 52 also define angles with the longitudinal axis of the securing device, the apices of these angles pointing in an opposite direction to the direction in which the device 18 is screwed-in.

Since the diameter of the circle defined by the movable parts 52 is greater than the diameter of the holes 17, the movable parts 52 are forced to move in essentially the opposite direction to the direction in which the device is screwed-in, as the device 18 is screwed into the recess 47. The movable parts 52 will therewith be deformed elastically, meaning among other things

that said parts will store potential kinetic energy. As the securing device 18 is screwed further in and reaches the recess 34, the potential kinetic energy stored in the movable parts 52 will be converted to kinetic energy for a very brief period, causing the movable parts 52 to "snap" in the screwing direction, in against the bottom surface 34A of the recess 34.

Figure 7 shows a fastening device 22 inserted in a hole 17 and secured by a securing device 18. After having snapped into the groove 34, the projection 54 is forced outwards as the surfaces 56, 57 are brought into contact with the surfaces 43, 44 as the securing device 18 is screwed further in.

It will be understood that the securing device can be constructed in several different ways within the scope of the invention. An alternative embodiment of a securing device 118 is illustrated schematically in the sectional view of Figure 8. This securing device also has a snap-locking function. When the device 118, which is produced from an elastically deformable material, is inserted into a hole 17, the movable parts 152 - which in the absence of load define slightly acute angles with the longitudinal axis of the device 118 in its direction of insertion into the hole 17 - the movable parts 152 are squeezed together by the hole-defining walls to the position referenced 152A in the Figure. In this embodiment, the movable parts contain their maximum potential kinetic energy when in the illustrated compressed state 152A. As the device 118 is moved further into the hole 17, the outermost edges of the movable parts will gradually be located furthest to the rear in the direction of movement of the device 118 and will pass the edge of a recess in the hole 17, for instance corresponding to the recess 34 in Figure 3. The movable parts will therewith snap back to their original state 152, in which said parts effectively lock the fastening device. It will be understood that this embodiment is intended primarily for permanent fixation of vertebrae.

Figure 9 illustrates another embodiment of the invention. This Figure is a side view of a vertebrae fixation device 110 which is intended to fixate three vertebrae, namely a cranially loca-

ted vertebrae 111A, a caudally located vertebrae 111B and a vertebrae 111C which lies therebetween. Located between the vertebrae 111A and 111C and between the vertebrae 111C and 111B respectively are bodies 112 which may either comprise intervertebral discs or protheses for such discs, or of any other type of body whatsoever, either synthetic or natural, possibly a part taken from the actual body of the patient and capable of replacing intervertebral discs. The illustrated fixation device 110 comprises a generally rectangular plate 113 which extends in the direction of its longitudinal axis over the bodies 112 and the vertebrae 111C and lies partially against the cranial edge 114B of the caudal vertebrae 111B and against the caudal edge 114A of the cranial vertebrae 111A. The plate 113 is provided in the vicinity of its cranial and caudal short sides 116A, 116B with respective through-penetrating holes 117, through which fastening devices 122 are intended to fix the plate 113 to the vertebrae 111A, 111B. The plate 113 is also provided centrally of the vertebrae 111C with at least one through-penetrating hole 117A, which is also intended to receive a fastening device for fixing the plate to the vertebrae 111C. All fastening devices 122 are locked in respective holes 117, 117A with the aid of securing devices 123.

It will be seen from Figure 9 that the length of the plate 113 is greater than the distance between the vertebrae 111A and 111C, although only by a small part of the total length of the plate 113. For size and weight reasons, and also to reduce any negative effect on peripheral organs, the plate 113 is provided with a bevelled or chamfered edge 119.

For strength reasons, analogous with those disclosed above in conjunction with the description of the Figure 2 embodiment, the holes 117 are angled in a cranial direction at the cranial 111A and in a caudal direction at the caudal vertebrae 111B. Since these strength reasons cannot be applied in the same way with regard to the hole or holes 117A and the vertebrae 111C, the hole or the holes 117A may lie in a dorsally directed plane.

It will be observed that none of the illustrated members, organs, projections, elements or the like project up from or are in any way raised above the ventral surface of the inventive fixation device.

It will also be understood that the described and illustrated exemplifying embodiments of the invention are merely intended as illustrations and do not limit the scope of the invention. It will be obvious to the skilled person that many different embodiments of the invention are conceivable within the scope of the invention.

Claims

1. A vertebral fixation device which is intended to be fitted to the ventral side of the spine for fixating adjacent vertebrae (11A, 11B) in relation to one another, wherein the device includes a generally rectangular plate (13) having generally rounded corners (15), elongated fastening devices (22), such as screws, for fixing the plate (13) to said adjacent vertebrae (11A, 11B), through-penetrating holes (17) provided at least at the corners (15) of the plate for receiving said fastening devices (22), securing devices (18) for securing the fastening devices (22) to the plate (13), and at least one pair of pins (31) provided respectively on the cranial and caudal sides (16A, 16B) of the plate (13) for holding the plate (13) in position when fixing the plate with the aid of said fastening device (22), **characterized** in that

a) the length of the plate (13) slightly exceeds the distance between the adjacent vertebrae (11A, 11B);

b) the through-penetrating holes (17) on the cranial side (16A) of the plate (13) in the dorsal direction are angled cranially, whereas the through-penetrating holes (17) on the caudal side (16B) of the plate (13) in the dorsal direction are angled caudally; and

c) the securing devices (18) include movable parts (52) which lock firmly in recesses (34) provided in the through-penetrating holes (17) and/or in the fastening device (22).

2. A device according to Claim 1, **characterized** in that the length of the plate (13) exceeds the distance between the adjacent vertebrae (11A, 11B) by 1-10 mm.

3. A device according to Claim 1 or 2, **characterized** in that the movable parts (52) of the securing devices (18) lock firmly with a snap-locking action.

4. A device according to any one of the preceding Claims, **characterized** in that the ventral surface (32) of the plate (13) is essentially smooth when the plate (13) is attached to the spine.

5. A vertebral fixating device which is intended to be fitted on the ventral side of the spine to fixate at least three adjacent vertebrae (111A, 111B, 111C) in relation to one another, wherein the device includes a generally rectangular plate (113) having generally rounded corners, elongated fastening devices (122), such as screws, for fixing the plate (113) to the adjacent vertebrae (111A, 111B, 111C), through-penetrating holes (117, 117A) provided at the plate corners for receiving said fastening devices (122) and level with the vertebra or vertebrae (111C) located between the most cranially and the most caudally positioned vertebra (111A, 111B) respectively, securing devices (123) for securing the fastening devices (122) to the plate (113), and at least one pair of pins arranged respectively on the cranial and the caudal side (116A, 116B) of the plate for holding the plate in position when fixating said plate with the aid of the fastening devices (122), **characterized** in that

a) the length of the plate (113) slightly exceeds the distance between the most caudal and the most cranial vertebra (111A, 111B);

b) the through-penetrating holes (117) on the cranial side (116A) of the plate (113) in the dorsal direction are angled cranially, and the through-penetrating holes (117) on the caudal side (116B) of the plate (113) in the dorsal direction are angled caudally;

c) the securing devices (123) include movable parts which lock firmly into recesses provided in the through-penetrating holes (117, 117A) and/or in the fastening devices (122).

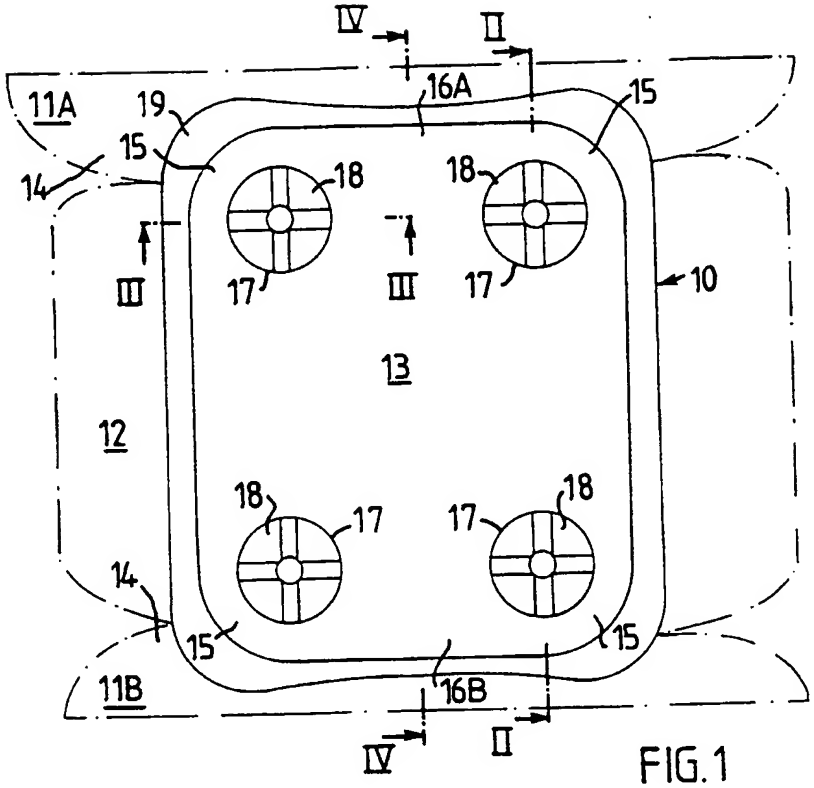
IV
II
11A
19
16A
15
15
14
18
18
III
17
III
17
10
13
12
18
17
17
18
14
15
15
11B
16B
IV
II

FIG.1

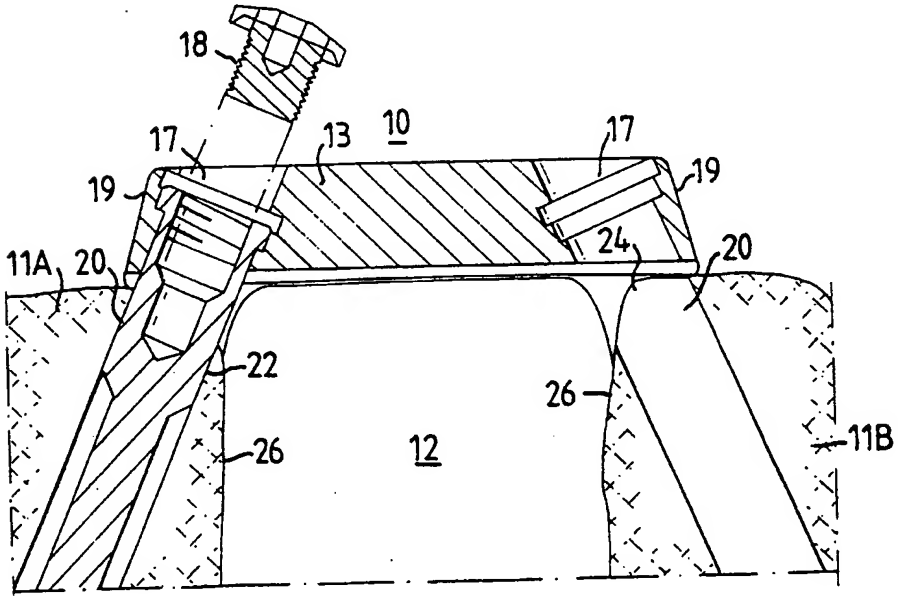
18
17
13
10
17
19
19
11A
20
24
20
22
26
26
12
11B

FIG.2

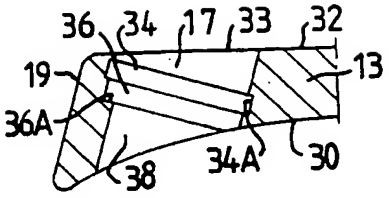

FIG.3

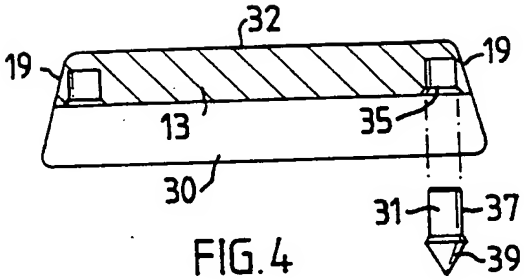

FIG.4

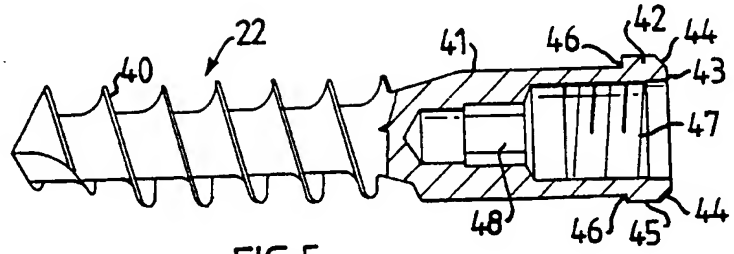

FIG.5

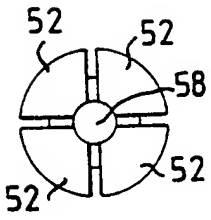

FIG.6A

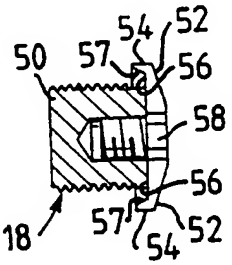

FIG.6B

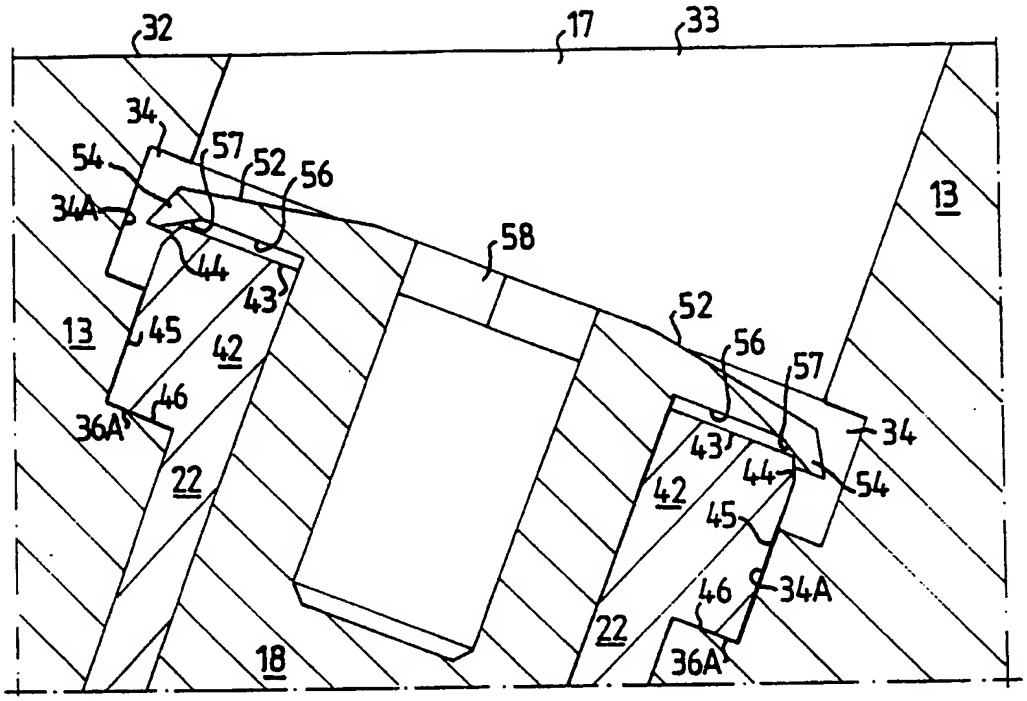

FIG.7

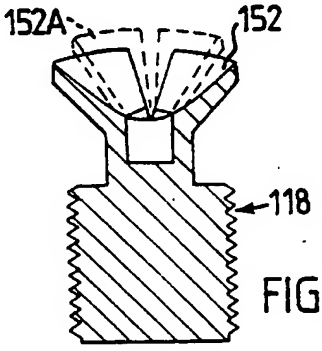

FIG.8

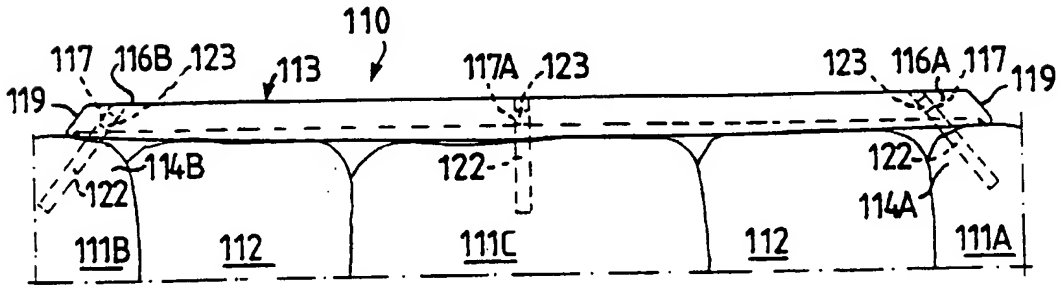

FIG.9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00412

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: A61B 17/58, A61F 2/44
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: A61B, A61F, F16B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3741205 (K.L. MARKOLF ET AL), 26 June 1973 (26.06.73), column 4, line 6 - line 11, figures 1-7, claim 1 --	1-5
A	US, A, 4484570 (F. SUTTER ET AL), 27 November 1984 (27.11.84), figures 1-19, claims --	1-5
A	US, A, 5147361 (S. OJIMA ET AL), 15 Sept 1992 (15.09.92), figure 1, abstract --	1-5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 July 1994	09 -08- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Hans Presto Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00412

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5108395 (J.-M. LAURAIN), 28 April 1992 (28.04.92), figures 1-9, abstract -- --------	1-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/07/94

International application No.
PCT/SE 94/00412

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3741205	26/06/73	NONE	
US-A- 4484570	27/11/84	CH-A,B- 648197	15/03/85
		DE-A,C- 3027138	03/12/81
US-A- 5147361	15/09/92	DE-A,C- 4038082	06/06/91
		JP-A- 3002896	09/01/91
US-A- 5108395	28/04/92	FR-A,B- 2651992	22/03/91